Comparision of Neutrophil Gelatinase-associated Lipocalin and Renal Resistive Index as Acute Kidney Injury Predictor in Critically Ill Patients at ICU H. Adam Malik Hospital Medan

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Introduction

Acute kidney injury (AKI) is a condition that describes as a broad spectrum from mild kidney function impairment to permanent kidney damage and complete loss of kidney function. AKI is a complication that is often found in critically ill patients treated in the Intensive Care Unit (ICU) [2]. Neutrophil gelatinase-associated lipocalin (NGAL) is a glycoprotein that is stored in mature neutrophil granules and released by tubular kidney cells after an acute tubular damage.

Laboratory tests can detect an increase in NGAL several hours after tubular damage and are reported to predict AKI earlier than serum creatinine [1], [4], [8]. Apart from NGAL, Renal resistive index (RRI) also been reported to be a good early marker of AKI. In contrast to NGAL which is examined from blood, RRI is a sonographic index. Renal vasoconstriction is an early manifestation of AKI. Doppler ultrasound can measure RRI show changes in intrarenal or interlobar arcuate arteries blood flow profile [6].

Methods

This study is an observational analytic study with a prospective cohort design. Conducted at ICU of Haji Adam Malik Hospital Medan in April until May 2021 after obtaining approval from Health Research Ethics Commission and approved by the Ethics Committee of Medical Faculty, Sumatera Utara University and H. Adam Malik Hospital Medan. Sample in this study is 40 subjects. The sampling technique used non-probability sampling with consecutive sampling, where all subjects who came with consecutive sampling design. Conducted at ICU of Haji Adam Malik Hospital Medan in April until May 2021 after obtaining approval from Health Research Ethics Commission and approved by the Ethics Committee of Medical Faculty, Sumatera Utara University and H. Adam Malik Hospital Medan. Sample in this study is 40 subjects. The sampling technique used non-probability sampling with consecutive sampling, where all subjects who came with consecutive sampling design.
Basic data collection such as gender, age, admission diagnosis, laboratory results, and urine output monitoring by volunteers. Renal Doppler ultrasound performed to assess RRI (performed by researcher and confirmed by ICU supervisor) and urine NGAL collected within 3 h of ICU admission. Then, urine output and creatinine clearance were monitored to assess whether AKI occurred according to the RIFLE criteria. Re-examination of urea and creatinine levels was carried out within 24 h of treatment.

Results

Characteristics of subjects, from 40 samples, number of male samples are 26 (66%) and female samples are 14 (35%), p = 0.001. Mean NGAL value sample are 80.35 ± 504.61 ng/dL with p = 0.01. Meanwhile, mean value of RRI are 0.68 ± 0.088 (p = 0.038), statistically not normally distributed. Mean value BMI in this study are 25.05 ± 2.214, p = 0.402. Mean age are 48.35 ± 14.143 years, p = 0.001. And incidence of AKI in this study are 21 (52.5%) samples.

There is a statistically and clinically difference in mean value of RRI between AKI and non-AKI groups, 0.719 ± 0.060 compared to 0.060 ± 0.077, with p = 0.001.

Table 1: Predictive value of RRI

<table>
<thead>
<tr>
<th>(%)</th>
<th>TP</th>
<th>TN</th>
<th>FP</th>
<th>FN</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRI</td>
<td>6</td>
<td>3</td>
<td>16</td>
<td>15</td>
<td>(28.6)</td>
<td>(15.8)</td>
<td>(71.4)</td>
<td>(71)</td>
<td>(78.9)</td>
</tr>
<tr>
<td></td>
<td>(28.6)</td>
<td>(15.8)</td>
<td>(71.4)</td>
<td>(71)</td>
<td>(78.9)</td>
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</tbody>
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TP: True positive, TN: True negative, FP: False positive, FN: False negative, PPV: Positive predictive value, NPV: Negative predictive value. RRI: Renal resistive index.

Table 1 describes predictive value of RRI on predicting AKI in ICU patients. In this study, value of True Positive was 28.6%, True Negative 15.8%, False Positive 84.2%, and False Negative 71.4%. RRI has a sensitivity of 71%, specificity of 84%, and accuracy of 87% in predicting AKI with AUROC = 0.873 (Figure 1). Meanwhile, Table 2 shows predictive value of NGAL on predicting AKI. Obtained a True Positive value of 66.7%, True Negative 89.5%, False Positive 10.5%, and False Negative 33.3%, with AUROC = 0.781 (Figure 2).

Table 2: Predictive value of NGAL

<table>
<thead>
<tr>
<th>(%)</th>
<th>TP</th>
<th>TN</th>
<th>FP</th>
<th>FN</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGAL</td>
<td>14</td>
<td>17</td>
<td>2</td>
<td>66</td>
<td>(66.7)</td>
<td>(89.5)</td>
<td>(10.5)</td>
<td>(33.3)</td>
<td>(78.9)</td>
</tr>
<tr>
<td></td>
<td>(66.7)</td>
<td>(89.5)</td>
<td>(10.5)</td>
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<td>(78.9)</td>
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Discussion

In our study, it found that RRI had a sensitivity of 71% and a specificity of 84% with an accuracy value of 87%. When compared with a study conducted by Muthukrishnan et al. (2019) where sensitivity is 57.1%,
conducted by Khawaja et al. (2019) which obtained a sensitivity of 78.5%, specificity of 88.8%, and study of Mahadevaiah et al. (2021) which obtained a 83.6% sensitivity and a 88.9% specificity. So, NGAL value in this study is not that much different. In addition, in this study, NGAL value was statistically significant and could predict incidence of AKI [3].

Based on the results of our study, it is known that RRI has better sensitivity than NGAL in predicting incidence of AKI in critically ill patients. However, a high NGAL value can also be a marker of AKI, because it has a high sensitivity. This is because NGAL is a glycoprotein that stored in mature neutrophil granules and found to be released by renal tubular cells after acute tubular damage. Laboratory examination can detect an increase in NGAL several hours after the occurrence of tubular damage [1], [3], [5].

Limitations in our study is RRI and NGAL cannot measure mortality rate because in this study there is no observations on outcome of specified samples.

Conclusion

RRI has better sensitivity than NGAL in predicting incidence of AKI. However, RRI and NGAL can be a good marker to predict incidence of AKI.

References

PMid:33964336

PMid:23573420

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